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THE PHYSICAL BASIS OF PRECOCITY AND DULLNESS.

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THE PHYSICAL BASIS OF PRECOCITY AND DULLNESS.*

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In December, 1891, I received the permission of the St. Louis Board of Public Schools to collect physical measurements of the school children.

The investigation began on January 4, 1892, and was finished the fourth week in March, having extended over eleven of the fourteen weeks of winter. The weight, height, length and breadth of head, vital capacity of chest, acuteness of vision, nationality of parents, and many other facts were secured from thirty-three thousand five hundred boys and girls. The larger part of the measurements were made by the teachers, whose hearty co-operation and efficient service in this work should earn them the gratitude of every friend of science.

The great store of facts thus obtained has been used to determine the laws of normal growth of the children of St. Louis in the hope that on this firm ground may be established a system of grading which shall take into account the physical capacity of the pupil in the apportionment of school tasks. An adaptation of mental work to strength is no new idea. Many a sporadic attempt has been made to modify the standard requirements established for the average boy or girl in favor of the exceptionally weak or strong. Such efforts have rested in the past on pure empiricism. Only when the laws of growth are accurately known, is it possible to know with certainty how much the growth of an individual exceeds or falls below the normal mean, and without this knowledge the

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* Read before The Academy of Science of St. Louis, March 6, 1893.

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regulation of mental labor from a physical standpoint is a venturesome groping rather than a scientific deduction.

The rational basis for this far-reaching reform in school hygiene is fast being laid. Foreign governments are making extended anthropometric measurements of children of all ages, and in our own land private enterprise and zeal for the advancement of learning have borne the burden of investigations that should be matters of public concern. Indeed, it is an American physiologist, Henry P. Bowditch, to whom must be given the honor of having first measured weights and heights of boys and girls in numbers sufficiently large to fix with certainty the general laws of growth.

It is evident that a due regard must be paid to exceptions in the application to special classes of laws true only of the mean of all classes at each age in the period of development. The dull and the precocious constitute such special classes. It is therefore of the highest interest and importance to determine whether dullness and precocity are associated with a physical variation from the mean so palpable that it can be recognized by the coarse methods of investigation practicable in school work.

Of these methods, none is more useful than weighing, partly because it is easy to weigh and partly because the weight has a very close relation to strength. The weight in fact may be looked upon as an index of physical development. By weighing then may be answered the questions: Are dull children in the mean weaker and precocious children in the mean stronger than the average child? Is there a physical basis for precocity and dullness? Is mediocrity of mind associated in the mean with mediocrity of physique? All these questions must be answered in the affirmative, and I will now ask you to examine the method by which this answer has been reached.

The course of study in the Public Schools of St. Louis is divided into eight grades, of which the first is the lowest. To these must be added the kindergartens and the High School, including the relatively small Normal School for the training of women to be teachers. Children are admitted to the kindergartens at six years. Some pupils will be found in

the High School at age twenty-two. In the higher grades, however, the number of girls over seventeen and of boys over sixteen years of age is too small to serve as material for our present needs. My conclusions are therefore limited to twelve years in the life of girls and eleven years in the life of boys.

TABLE No. 1.

Distribution by School Grades of the weights of boys aged 9.

GRADES.	I.	II.	III.	IV.	V.
Pounds.					
90	....	1	....	....	....
89	....	....	....	....	....
88	....	1	....	....	....
87	....	....	....	....	....
86	....	....	....	....	....
85	....	....	1	....	....
84	....	....	....	....	....
83	1	....	....	....	....
82	....	2	1	....	....
81	....	....	1	....	....
80	....	....	1	....	....
79	....	....	....	1	....
78	....	4	....	....	....
77	....	1	4	....	....
76	....	5	3	1	....
75	....	1	1	1	....
74	1	5	2	....	1
73	1	7	4	....	....
72	3	5	4	1	....
71	3	6	4	2	....
70	7	16	6	1	....
69	5	10	6	1	....
68	1	17	6	....	....
67	1	21	10	2	....
66	3	29	8	2	....
65	11	22	14	3	1
64	21	53	18	2	....
63	17	44	22	4	....
62	25	63	13	....	....
61	25	54	23	4	....
60	29	72	21	3	....
59	29	61	16	2	....
58	27	74	23	3	....
57	37	65	17	1	....
56	33	62	14	1	....
55	39	91	21	3	1
54	30	72	18	2	....
53	39	78	10	....	....
52	33	52	18	1	....
51	28	50	14	....	....
50	25	48	10	1	....
49	20	28	6	1	....
48	14	24	4	....	....
47	19	14	1	1	....
46	8	8	....	....	....
45	13	11	1	....	....
44	7	7	3	....	....
43	5	3	....	....	....
42	1	2	....	....	....
41	3	2	1	....	....
40	2	....	1	....	....
39	2	....	1	....	....
38	1	1	1	....	....
37	....	....	1	....	....
36	....	....	1	....	....
35	1	....	....	....	....
34	....	1	2	....	....
33	....	1	....	....	....
32	....	1	....	....	....
Total....	570	1195	357	44	3
50 p. c.....	285	597.5	178.5	22	....

Within this period, children of the same age are found in several grades. Thus of 1,334 girls aged thirteen whose weight was recorded, 6 were in Grade I, and 6 in the High School, the remainder being distributed through the other grades, the greatest number (363) being in Grade IV. But here the number in the highest and lowest grades is again too small for our present purpose. For this reason, no number less than 20 has served as a basis for the calculations we are presently to consider.

The distribution of the weights of boys aged nine by School Grades is shown in Table No. 1, compiled from the forms filled out in the schools by those who weighed the pupils.

In this table the weight is expressed in pounds in the column on the left, and opposite each pound is placed the number of boys of that weight in each grade.

The mean weight is obtained for each grade by adding the figures in the grade column, beginning at the bottom, until the sum cannot be increased by the next number without exceeding 50 per cent of the total number in the grade. This point is marked in the columns of the above table by an underscore. Somewhere in the first number above this line lies the mean of all the observations in the column. Its position may be determined by interpolation. An example will make this clear. Let us calculate the mean weight of boys of nine years in Grade II.* Fifty per cent of the 1,195 boys in this age and grade is 597.5. Adding up the column we reach 556 at 56 pounds. The next number in the column would make 621, which is more than 50 per cent of 1,195. The mean is therefore greater than 57 pounds and less than 58 pounds. The difference between 597.5 and 556 is 41.5, which is 64 per cent of 65. Thus the mean weight is 57.64 pounds.

The mean weight in pounds for each grade is printed in DOUBLE FACED type in Table No. 2 (boys), and Table No. 3 (girls), along with the number of observations (lower case type) from which each weight was calculated. The mean weight at each age irrespective of grade is also given. In Table No. 4, the weights in the two preceding tables are expressed in kilograms, the figures for boys being in DOUBLE FACED type.

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* This method is that used by Galton. See *Natural Inheritance*, London, 1889, Chapter IV.

TABLE No. 2.

Age at nearest Birthday.	Mean Weights	Weights of St. Louis School Boys distributed by Grades.									Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**43,74** 707	**43,58** 622	**45,29** 76									Pounds.
Seven	**47,73** 1814	**45,55** 534	**48,48** 1205	**52,00** 59								"
Eight	**52,58** 2188	**47,80** 28	**51,79** 1497	**54,43** 622	**57,00** 24							"
Nine	**57,75** 2188		**55,87** 570	**57,64** 1195	**59,66** 357	**61,75** 44						"
Ten	**62,48** 2064		**60,19** 207	**61,14** 789	**64,00** 766	**64,91** 269						"
Eleven	**68,47** 1644		**63,50** 59	**65,45** 311	**68,12** 664	**69,24** 546	**71,29** 123	**73,34** 33				"
Twelve	**73,61** 1242		**70,00** 28	**69,50** 104	**72,17** 430	**73,86** 602	**74,69** 306	**77,29** 141	**76,50** 22			"
Thirteen	**79,85** 946			**74,25** 38	**75,95** 149	**78,43** 352	**80,90** 336	**82,17** 229	**83,50** 78	**82,00** 34		"
Fourteen	**88,08** 498				**81,00** 46	**84,00** 184	**87,83** 194	**87,20** 242	**93,63** 143	**97,50** 88	**86,50** 25	"
Fifteen	**100,20** 203					**89,00** 26	**95,33** 58	**99,17** 125	**105,50** 103	**105,17** 93	**105,08** 51	"
Sixteen	**114,17** 71							**114,50** 25	**104,00** 23	**114,00** 60	**123,00** 66	"

TABLE No. 3.

Age at nearest Birthday.	Mean Weights	Weights of St. Louis School Girls distributed by Grades.										Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**41,84** 798	**41,65** 711	**45,08** 71									Pounds.
Seven	**45,84** 1714	**43,87** 599	**46,76** 1031	**49,88** 67								"
Eight	**50,35** 2147	**46,50** 35	**49,60** 1408	**52,10** 643	**53,17** 45							"
Nine	**55,17** 2055		**52,57** 445	**55,44** 1175	**57,18** 365	**60,00** 48						"
Ten	**60,46** 1947		**57,00** 128	**59,59** 739	**61,15** 798	**61,64** 235						"
Eleven	**65,64** 1708		**66,34** 40	**62,95** 293	**65,50** 654	**66,77** 551	**68,12** 133					"
Twelve	**73,23** 1676		**71,75** 21	**69,80** 116	**71,50** 351	**72,74** 657	**75,13** 347	**75,92** 139	**78,50** 27			"
Thirteen	**83,73** 1343			**79,50** 41	**76,50** 129	**81,92** 363	**82,78** 328	**86,95** 301	**87,63** 121	**88,50** 37		"
Fourteen	**93,94** 1082				**90,50** 55	**87,17** 147	**92,67** 230	**94,64** 289	**96,15** 190	**99,00** 100	**103,12** 39	"
Fifteen	**103,20** 690					**98,50** 37	**100,96** 69	**99,83** 161	**104,00** 146	**104,58** 153	**105,15** 109	"
Sixteen	**110,06** 420							**108,12** 45	**107,38** 59	**110,29** 104	**113,57** 188	"
Seventeen	**115,69** 230									**111,00** 24	**116,00** 182	"

TABLE No. 4.

Age at nearest Birthday.	Mean Weights	Weights of St. Louis **BOYS** and Girls distributed by Grades.										Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**19,85** 18,99	**19,78** 18,90	**20,56** 20,46									Kilograms.
Seven	**21,66** 20,81	**20,68** 19,92	**22,02** 21,23	**23,61** 22,64								"
Eight	**23,87** 22,85	**21,70** 21,11	**23,52** 22,51	**24,70** 23,65	**25,88** 24,13							"
Nine	**26,22** 25,04		**25,38** 23,86	**26,20** 25,17	**27,10** 25,96	**28,03** 27,24						"
Ten	**28,36** 27,45		**27,33** 25,88	**27,74** 27,05	**29,06** 27,76	**29,46** 27,98						"
Eleven	**31,08** 29,80		**28,83** 30,12	**29,74** 28,58	**30,92** 29,74	**31,43** 30,31	**32,41** 30,93	**33,29**				"
Twelve	**33,41** 33,25		**31,78** 32,57	**31,55** 31,69	**32,78** 32,46	**33,53** 33,02	**33,91** 34,11	**35,05** 34,47	**34,73** 35,64			"
Thirteen	**36,25** 38,00			**33,73** 36,09	**34,50** 34,73	**35,61** 37,19	**36,73** 37,58	**37,27** 39,47	**37,91** 39,78	**37,23** 40,18		"
Fourteen	**39,98** 42,65				**36,77** 41,09	**38,14** 39,57	**39,87** 42,07	**39,59** 42,97	**42,51** 43,65	**44,27** 44,95	**39,27** 46,82	"
Fifteen	**46,85** 46,85					**40,41** 44,72	**43,28** 45,83	**45,02** 45,32	**47,89** 47,22	**47,74** 47,48	**47,71** 47,74	"
Sixteen	**51,83** 49,96							**51,98** 49,09	**47,22** 48,75	**51,76** 49,69	**55,84** 51,56	"
Seventeen	52,52									50,39	52,66	"

When these tables are examined it is seen that in each age the mean weight of pupils in the higher grades is greater than the mean weight of all pupils at that age and exceeds still more the mean weight of pupils in the lower grades.* This fact is more conspicuous when the grade weights in Tables No. 2 and No. 3 are expressed graphically. The curves thus secured are reproduced in Plate I. The mean weight of all pupils at each age is marked on the curve by a small perpendicular line near the figure indicating the age. The abnormal deviation of the ends of some of the curves from the general slope of the curve is due to the number of observations at these points being too small for trustworthy results.

The truth which the curves in Plate I express is very plain. They declare in unmistakable lines that precocious children are heavier and dull children lighter than the mean child of the same age. They establish a physical basis of precocity and dullness.

Whether means or averages are the more trustworthy tools in investigations of this sort is a matter of opinion. So long as their respective value is a subject of controversy investigators will accept no results as final which can be supported only by means. It must therefore be my first concern to show that the law: MEAN PRECOCITY IS RELATED TO MEAN PHYSICAL DEVELOPMENT may with equal truth be written: AVERAGE PRECOCITY IS RELATED TO AVERAGE PHYSICAL DEVELOPMENT.

In Table No. 5 are found the average weights of boys distributed by school grades, and the average weights irrespective of grade. Pounds are in DOUBLE-FACED type and kilograms in "lower case" type. The number of observations is in each case the same as in Table No. 2.

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* The end weights of the series at same age are calculated from so small a number of observations that they sometimes vary from the law which the more numerous observations toward the middle of the series show to be true.

PLATE I.

MEAN WEIGHTS OF ST. LOUIS SCHOOL CHILDREN, DISTRIBUTED BY GRADES.

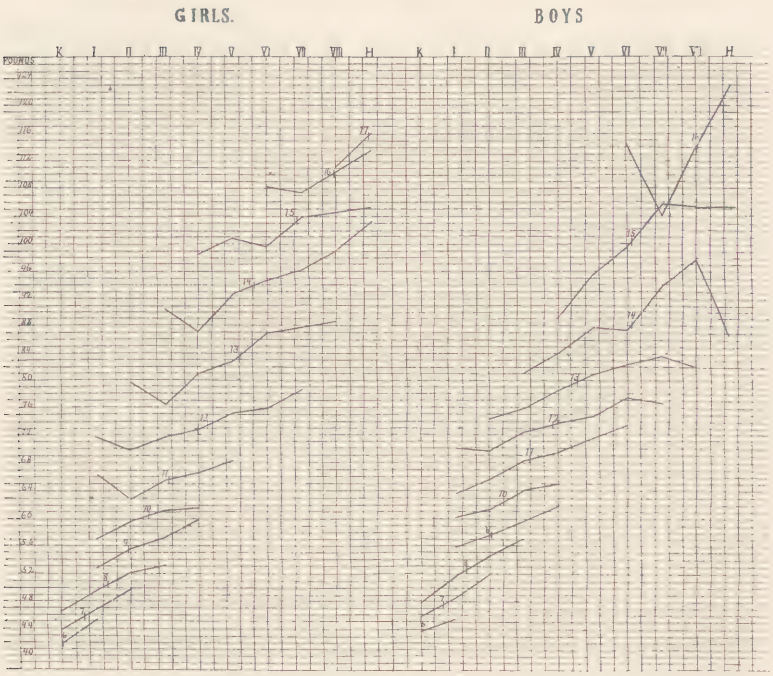

TABLE No. 5.

Age at nearest Birthday.	Average Weights	Average Weights of St. Louis School **Boys** distributed by Grades.									Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**43,49** 19,75	**43,27** 19 64	**44,99** 20,42									**Pounds** Kilogr.
Seven	**47,73** 21,67	**45,26** 20,79	**48,49** 22,01	**52,75** 23,95								**Pounds** Kilogr.
Eight	**52,39** 23,78	**48,21** 21,89	**51,58** 23,42	**54,32** 24,66	**57,33** 26,02							**Pounds** Kilogr.
Nine	**57,41** 26,06		**55,52** 25,22	**57,56** 26,13	**59,26** 26,90	**61,91** 28,11						**Pounds** Kilogr.
Ten	**62,38** 28,32		**60,36** 27,41	**61,10** 27,74	**63,57** 28,86	**64,33** 29,20						**Pounds** Kilogr.
Eleven	**68,30** 31,00		**64,22** 29,16	**65,55** 29,76	**67,77** 30,77	**71,39** 32,41	**72,37** 32,85	**74,12** 33,65				**Pounds** Kilogr.
Twelve	**73,82** 33,51			**70,63** 32,06	**71,86** 32,63	**74,31** 33,73	**75,26** 34,17	**77,83** 35,33				**Pounds** Kilogr.
Thirteen	**80,65** 36,61			**74,00** 33,60	**77,00** 34,96	**78,83** 35,79	**81,94** 37,20	**83,69** 38,00	**86,83** 39,42	**82,26** 37,33		**Pounds** Kilogr.
Fourteen	**89,09** 40,44				**84,63** 38,42	**85,59** 38,86	**90,68** 41,17	**87,75** 39,87	**93,28** 42,35	**98,22** 44,59	**91,88** 41,72	**Pounds** Kilogr.
Fifteen	**101,80** 46,22					**92,52** 42,00	**98,71** 44,81	**99,38** 45,12	**106,16** 48,20	**104,72** 47,54	**103,27** 46,88	**Pounds** Kilogr.
Sixteen	**113,65** 51,60							**116,60** 52,93	**102,00** 46,31	**114,57** 52,01	**123,77** 56,19	**Pounds** Kilogr.

This table shows that the statements in the preceding pages are supported by averages as well as means, and on this double foundation the law of the relation between precocity and physical development may well rest secure.

It is not enough to know that the mean and the average child follow this law. We must also know whether small precocious children are heavier than small dull children and on the other hand, whether large precocious children are heavier than large dull children.

To determine this we will have recourse to Galton's schemes of distribution.* If a thousand children at the same age were placed in line according to stature, the height of the middle or 500th child would be the mean (Galton's nomenclature) of the heights of the entire number. The larger children would be at one end of the line and the smaller children at the other. If we took the 300th child, counting from the middle of the line in both directions, we should have one large and one small child at an equal distance from the mean, and the weights of these children might be safely compared with the weights of children similarly selected from a series of 1,000 at another age.

A process analogous to this has been followed with the children's weights in the present instance. I have taken at each school grade and age 20 and 80 per cent of the total observations. The figures in the pound column opposite which these percentages fall represent respectively the weights of a small and a large child, and these weights may be compared with those obtained in a similar manner from other school grades and ages. Table No. 6 is made from the 20 "percentile," as Galton would call it, and thus contrasts the weight of small children in different school grades, and Table No. 7 is made from the 80 "percentile," representing the large children. In both tables, boys' weights are printed in DOUBLE-FACED type. The mean weights of small children (20 "percentile"), irrespective of school grades, are placed in the column on the left in Table No. 6 and the mean weights of large children (80 "percentile"), irrespective of school grade, occupy a similar position in Table No. 7.

* Fully explained in Galton's *Natural Inheritance*, London. 1889. Chap. IV.

TABLE No. 6.

Age at nearest Birthday.	Mean Weights	Weights of small Boys and Girls (20 "percentile") by School Grades.									Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**40,33** 38,31	**40,34** 38,22	**39,87** 40,15									Pounds.
Seven	**43,55** 41,58	**41,90** 40,00	**44,45** 42,78	**46,93** 45,23								"
Eight	**47,58** 45,46	**42,80** 41,33	**46,69** 44,87	**49,78** 47,10	**52,80** 48,00							"
Nine	**52,33** 49,90		**50,00** 47,64	**52,73** 50,32	**53,64** 51,46	**55,93** 52,60						"
Ten	**56,31** 53,96		**54,46** 51,30	**55,15** 52,97	**58,01** 54,43	**57,91** 57,29						"
Eleven	**61,42** 58,99		**56,60** 55,50	**59,25** 56,97	**61,20** 59,21	**63 28** 59,89	**65,66** 61,27	**65,80**				"
Twelve	**66,20** 64,77		**62,60** 59,50	**62,60** 61,70	**64,55** 63,77	**67,37** 64,62	**67,65** 66,78	**69,40** 67,96	**63,20** 69,60			"
Thirteen	**70,80** 72,79			**65,60** 71,60	**68,95** 68,64	**70,13** 70,54	**71,27** 72,93	**73,97** 75,73	**74,60** 77,44	**71,70** 77,80		"
Fourteen	**78.65** 80,90				**75,30** 77,50	**75,70** 79,23	**79,70** 81,37	**78,40** 82,18	**81,80** 84,33	**86,30** 87,67	**79,00** 87,40	"
Fifteen	**85,95** 92,09					**81,13** 83,40	**84,60** 89,80	**85,00** 89,14	**91,53** 93,40	**87,87** 95,23	**89,10** 91,40	"
Sixteen	**98,12** 100,50							**103,00** 94,00	**89,80** 97,40	**98,00** 101,80	**111,20** 103,94	"
Seventeen	**113,10** 105,25									99,80	105,34	"

TABLE No. 7.

Age at nearest Birthday.	Mean Weights	Weights of large **Boys** and Girls (80 "percentile") by School Grades.										Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**47,83** 45,92	**47,42** 45,71	**50,90** 49,95									
Seven	**52,42** 50,57	**49,46** 48,47	**53,20** 51,64	**59,20** 55,87								
Eight	**58,02** 55,71	**54,35** 49,75	**57,04** 54,73	**59,87** 56,92	**65,40** 60,00							
Nine	**63,36** 61,34		**61,84** 59,00	**63,13** 61,33	**65,40** 63,00	**70,20** 69,70						
Ten	**69,21** 67,37		**66,27** 63,70	**67,22** 65,69	**70,17** 68,22	**70,94** 69,44						
Eleven	**75,67** 73,93		**72,07** 72,50	**73,08** 71,55	**75,07** 73,77	**76,77** 75,48	**77,13** 75,77	**83,40**				
Twelve	**81,35** 82,97		**77,40** 77,60	**78,55** 79,80	**79,40** 81,35	**81,00** 82,87	**82,53** 86,65	**85 26** 85,20	**87,20** 87,20			
Thirteen	**89,90** 96,41			**80,68** 89,40	**83,70** 89,20	**87,23** 93,93	**91,56** 97,16	**93,03** 100,29	**98,35** 102,60	**89,07** 104,60		
Fourteen	**103,04** 107,08				**94,80** 105,50	**96,05** 104,15	**104,07** 105,70	**102,65** 108,05	**102,76** 106,71	**109,70** 112,50	**107,00** 108,60	
Fifteen	**117,48** 113,82					**101,20** 106,60	**110,85** 112,10	**115,50** 110,63	**120,10** 120,11	**121,10** 114,47	**119,90** 116,05	
Sixteen	**129,93** 123,00							**126,00** 119,00	**114,20** 115,20	**136,00** 121,40	**137,80** 124,80	
Seventeen	**136,93** 126,25									126,20	126,53	

The coincidence of high weights and high school grades so clearly demonstrated by previous tables is seen with equal clearness here. Small dull children are under, small precocious children above the mean weight of small children of their age, and the same is true of large children.

If weight is indeed a good index of physical development, it is *a priori* probable that height, girth of chest and other dimensions follow the law induced above. An analysis of the measurements at any age will show that this assumption is well grounded. Age 10, boys, and age 12, girls, may be selected for this purpose, as the number of observations at these ages is large and the pupils are found in several grades. The analysis of the height standing of boys aged 10 and girls aged 12 is seen in Tables No. 8 and No. 9 respectively.

TABLE NO. 8.

The Mean and the Average Height Standing of Boys, Aged 10.

School Grade.	Mean.	Average.	No. of Observations.
I	126.50 cm.	126 13 cm.	109
II	129.39	128.78	440
III	130.29	129.96	436
IV	131.22	131.99	185
V	.....	.....	11
VI	.....	.....	3

TABLE NO. 9.

The Mean and the Average Height Standing of Girls, Aged 12.

School Grade.	Mean.	Average.	No. of observations.
I	.....	.....	14
II	136.06 cm.	135.93 cm.	73
III	139.04	138.97	217
IV	140.08	139.77	395
V	141.96	140.57	227
VI	141.90	141.80	110
VII	.....	.....	14

It appears that precocious children are taller as well as heavier than dull children.

The measurement of the girth of chest in girls is more difficult than in boys, and in both sexes is more subject to error than the measurement of weight or height. For this reason it is advisable, at least in the case of girls, to divide

the material into three groups, rather than to treat it by single grades. The result is not materially different in either method, but the means of the three large groups are more deserving of confidence than the means of the more numerous grades.

TABLE NO. 10.

Distribution of Girls, Aged 12. Girth of Chest at Forced Expiration.

School Grade.	No. of Observations.
I	13
II	68
III	204
IV	381
V	210
VI	111
VII	13
VIII	3

Grade IV, containing the greatest number of girls, is the mean grade at this age. With it may be compared the mean girth of chest of the 285 girls in grades I, II and III, and the 337 girls in the higher grades V, VI, VII and VIII. The following results appear:

TABLE NO. 11.

The Girth of Chest at Forced Expiration in Dull, Mediocre and Precocious Girls, Aged 12.

School Grade.	Mean.	No. of Observations.
I, II, III	66.21 cm.	285
IV	66.78	381
V, VI, VII, VIII	67.89	337

TABLE NO. 12.

The Girth of Chest at Forced Expiration in Boys, Aged 10.

School Grade.	Mean.	Average.	No. of Observations.
I	62.96 cm.	62.62 cm.	115
II	63.27	63.11	454
III	63.94	63.81	462
IV	64.24	64.32	189
V	.....	.....	12
VI	.....	.....	3

Successful pupils have larger chests than the unsuccessful.

The width of head, or distance from one parietal eminence to the other, measured with callipers, is also greater in more advanced pupils than in those less advanced.

TABLE NO. 13.

The Width of Head of Girls, Aged 12.

School Grade.	Mean.	Average.	No. of Observations.
I	.....	.....	11
II	144.25 mm.	143.68 mm.	68
III	145.52	144.77	193
IV	145.75	144.94	343
V	146.24	145.50	217
VI	148.08	147.64	89
VII	.....	.....	10
VIII	.....	.....	4

TABLE NO. 14.

The Width of Head of Boys, Aged 10.

School Grade.	Mean.	Average.	No. of Observations.
I	146.06 mm.	145.86 mm.	92
II	146.38	146.73	408
III	146.71	146.48	397
IV	147.45	147.21	170
V	.....	.....	21

NOTE.—The following information may be of interest. The classification of pupils is irrespective of nationality. The children were weighed on Fairbanks Standard Scales in indoor winter clothing. The shoes were taken off when the height standing was measured. The girth of chest was taken over the shirt in boys and over the dress in girls, in each case on a level with the nipples. The occasional corset was removed. Head measurements were made by undergraduates of the St. Louis Medical College.

So far as I am aware, the only other investigations into the relation between physical development and success in school life are recorded in the Inaugural Dissertations of Dr. Gratsianoff and Dr. Sack. Dr. Gratsianoff measured the children in Arzamas, a small town in the province of Nijni Novgorod. He claims, as I learn from the work of Sack, that successful pupils are larger than the unsuccessful and that the rate of growth is quicker in the successful. Sack (*Physical Development of the Children in the Middle Schools of Moscow.* 1892. Russian.) rejects the work of his predecessor, as founded "for the most part on a totally insufficient number of observations" (page 131). Sack's own results are derived from the examination of 4,245 boys, distributed among eight school grades; 2,600 were measured twice. Including the latter, the extent of Sack's material up to age 18 is seen in the following extract from his table on page 57:

Age.	No. Observed.	Age.	No. Observed.
7–8	1	12–13	772
8–9	13	13–14	830
9–10	76	14–15	744
10–11	450	15–16	738
11–12	671	16–17	833

No weights have been published. The author confirms Gratsianoff's

It cannot be by chance that ages ten and twelve have yielded these results, so exactly fulfilling the expectations raised by the analysis of weights. What is true of these ages is undoubtedly true of all ages in the period of development. There is no reason to apprehend that other dimensions, such as height sitting, span of arms, etc., are exceptions to the law which has been shown to exist in respect of weight, height standing, girth of chest and width of head.

We have thus far in this paper dealt with the dimensions of children of the same age. The relation between precocity and the rate of growth or yearly increase in size has not been considered, and to this most interesting subject we must now turn.

The material for the comparison of the rate of growth of dull and precocious children is found in the weights of boys and girls distributed by school grades. The manner of treating this material will be best understood by a statement of the method used in getting the weight of the mean dull and the mean precocious child at any age. Girls aged 13 may serve as an example. Their distribution by school grades is as follows:

School Grades.	No. of Observations.
I	6
II	41
III	129
IV	363
V	331
VI	300
VII	121
VIII	37
High School	6
Total	1,334

The mean success in school life of girls at this age is indicated by the mean of these nine grades. Fifty per cent

statement that the more successful children are taller and have larger chests than the less successful, but finds a uniform rate of growth in these dimensions.

My own results were reached before I knew of the work of the Russian scientists.

of the total number of girls is 667. Adding up the column, 464 is reached at Grade V; to add the girls in this grade would make the sum greater than 50 per cent of 1,334. The mean lies, therefore, in Grade V. The difference between 667 and 464 is 203, which is 61 per cent of 331. That is to say, a line drawn at the mean grade of girls, aged 13, would divide them into two groups, the one consisting of the High School, Grades VII, VI, and 61 per cent of the girls in Grade V, and the other, consisting of 39 per cent of Grade V, and Grades IV, III, II, and I. The total number would thereby be divided into two classes according to success in school life, and success in school life, like success in after life, is on the average a fair test of intelligence.

The actual division of the pupils into these two classes cannot be carried out until the number of observations at each pound in Grade V is multiplied by 0.61 and 0.39, thus making two columns, one of which contains 61 and the other 39 per cent of the observations in the grade. The former is added to the number of observations at each pound in Grades VI, VII, VIII, and the High School, and the latter similarly added to Grades IV, III, II, and I. The mean of the one group is the weight of the mean precocious girl and the mean of the other, the weight of the mean dull girl.

The weights calculated by this method for children of mean dullness and mean precocity are placed in Tables No. 15 and No. 16, in which the mean grade also appears.

TABLE NO. 15.

The Weight of the Boy of Mean Precocity and the Boy of Mean Dullness.

PRECOCITY.			DULLNESS.		
Age.	Grades.	Pounds.	Pounds.	Grades.	Age.
7	.70 I, II, III.....	48.64	46.69	Kn, .30 I	7
8	.29 I, II, III, IV.....	53.50	51.59	Kn., .71 I.....	8
9	.56 II, III, IV, V	58.64	56.12	I, .44 II	9
10	.96 III, IV, V, VI	64.05	60.95	I, II, .04 III.....	10
11	.25 III, IV, V, VI.....	69.57	66.96	I, II, .75 III.....	11
12	.45 IV,V, VI, VII, H. S..	75.24	72.26	I, II, III, .55 IV	12
13	.82 V, VI, VII, VIII.....	81.00	77.36	I, II, III, IV, .18 V.....	13
14	.88 VI, VII, VIII, H. S...	90.57	85.69	II, III, IV, V, 12 VI	14
15	.VII VIII, H. S....	105.27	94.78	II, III, IV, V, VI	15
16	.53 VIII, H. S.....	120.96	105.00	II,III,IV,V,VI,VII,.47 VIII.	16

TABLE NO. 16.

The Weight of the Girl of Mean Precocity and the Girl of Mean Dullness.

PRECOCITY.			DULLNESS.		
Age.	Grades.	Pounds.	Pounds.	Grades.	Age.
7	.76 I, II, III	46.96	44.68	Kn., .24 I	7
8	.27 I, II, III, IV	51.20	49.52	Kn., .73 I	8
9	.51 II, III, IV	56.25	54.32	I, .49 II	9
10	.88 III, IV, V, VI	61.34	59.44	I, II, .12 III	10
11	.22 III, IV, V, VI, VII,	66.73	64.84	I, II, .78 III	11
12	.48 IV,V,VI,VII, VIII	74.59	71.72	I, II, III, .52 IV	12
13	.61 V,VI,VII, VIII, H.S	86.43	80.39	I, II, III, IV, .39 V	13
14	.69 VI,VII, VIII, H.S	96.61	92.00	II, III, IV, 31 VI	14
15	.55 VII, VIII, H.S	104.54	100.03	II,III,IV,V,VI, .45 VII	15
16	.20 VIII, H. S	113.31	108.39	IV,V,VI,VII, .80 VIII	16

The meaning of these tables is shown graphically in Plate II. Here are seen three pairs of curves. The uppermost are the curves of increase in weight of boys and girls of mean precocity; the lowermost, the curves of increase in weight of boys and girls of mean dullness. The middle curves give the mean weights irrespective of grade. In each pair the curve of girls' weights is a broken line.

Tables No. 2 and No. 3 support the view that mean weight irrespective of grade, or, in other words, mean weight irrespective of success in school life, is also the mean weight of children of mediocre ability. If this view be correct, the curves of mean weight irrespective of grade may rightfully be compared with curves of weight of precocious and dull children, as has been done in Plate II. The fact that these curves of means irrespective of grade fall almost exactly between the curves of precocity and dullness justifies this comparison.

Again, the mean weight at each age, on the basis of intelligence, *i. e.*, the weight of the mediocre child, should be the same as the mean weight at each age irrespective of intelligence. The two preceding tables, No. 15 and No. 16, contain the mean weight of precocious and dull children. By adding these together at each age and dividing by 2, the weight of the mediocre child is secured. In Tables No. 17 and No. 18, these weights of mediocre children are compared with the

mean weights of the whole mass of observations at each age, irrespective of school grade.

TABLE NO. 17.

The Mean of the Weights of Boys of Mean Precocity and Dullness compared with the Mean Weight irrespective of School Grade.

Age.	Mean Precocity.	Mean Dullness.	Mean.	Mean irrespective of School Grades.
7	48.64 lbs.	46.69 lbs.	47.66 lbs.	47.73 lbs.
8	53.50	51.59	52.54	52.58
9	58.64	56.12	57.38	57.75
10	64.05	60.95	62.50	62.48
11	69.57	66.96	68.26	68.47
12	75.24	72.26	73.75	73.61
13	81.00	77.36	79.18	79.85
14	90.57	85.69	88.13	88.08
15	105.27	94.78	100.02	100.20
16	120.96	105.00	112.98	114.17

TABLE NO. 18.

The Mean of the Weights of Girls of Mean Precrocity and Dullness compared with the Mean Weight irrespective of School Grade.

Age.	Mean Precocity.	Mean Dullness.	Mean.	Mean irrespective of School Grades.
7	46.96 lbs.	44.68 lbs.	45.82 lbs.	45.84 lbs.
8	51.20	49.52	50.36	50.35
9	56.25	54.32	55.28	55.17
10	61.34	59.44	60.39	60.46
11	66.73	64.84	65.78	65.64
12	74.59	71.72	73.15	73.23
13	86.43	80.39	83.41	83.73
14	96.61	92.00	94.30	93.94
15	104.54	100.03	102.28	103.20
16	113.31	108.39	110.85	110.06

The coincidence in the two series is noticeable.

The three pairs of curves in Plate II may now be examined in detail. The three full lines of boys' weights run courses not strictly parallel. A slight divergence of the curves of the dull and the precocious is evident in the case of the older boys. This would seem to indicate that the difference in weight between dull and precocious boys increases as they grow older. It would further seem to show that this increasing divergence is associated chiefly with the acceleration of

growth at the beginning of puberty, and that precocious boys grow faster than dull boys.

These conclusions may perhaps have an element of truth, but the curves now under examination by no means prove their truth. For it must be noticed that the divergence in question is scarcely perceptible until ages 14 and 15 are reached, ages in which the number of observations is so small as to considerably increase the chance of error. No such divergence is seen in the case of girls' weights, in which the number of observations in the ages 14, 15, and 16 is very much larger. * Bearing this fact in mind, it may be affirmed that *the comparative rate of growth of dull, mediocre and precocious children of the same sex is the same at all ages from 7 to 16 inclusive.* The data at hand are not sufficient to decide whether this law is true of other ages in the period of growth.

Each boys' curve in Plate II is characterized by a gradual and very nearly uniform ascent until age 13 is reached. Here an acceleration begins, indicated by a more rapid rise of the curves, and this acceleration becomes still more rapid at age 14. It is the expression of the change which precedes puberty. A similar acceleration is seen in girls, but it takes place at an earlier age, the curves beginning their steeper rise at age 11. The curves in Plate II are plotted one directly above the other. The ordinates for the same age are made to coincide in all six curves. It can therefore be readily seen whether the period of acceleration begins earlier or later in dull than in precocious children. This seems not to be the case. *The acceleration in weight preceding puberty takes place at the same age in dull, mediocre and precocious children.*

The growth of boys and girls runs a parallel course in early childhood. At age 6, boys are heavier than girls, and this advantage is maintained for several years. But when the difference of sex begins to make itself felt, the relation between the weights of the sexes is changed, the boys lose their superiority and the curve of girls' weight rises above theirs.

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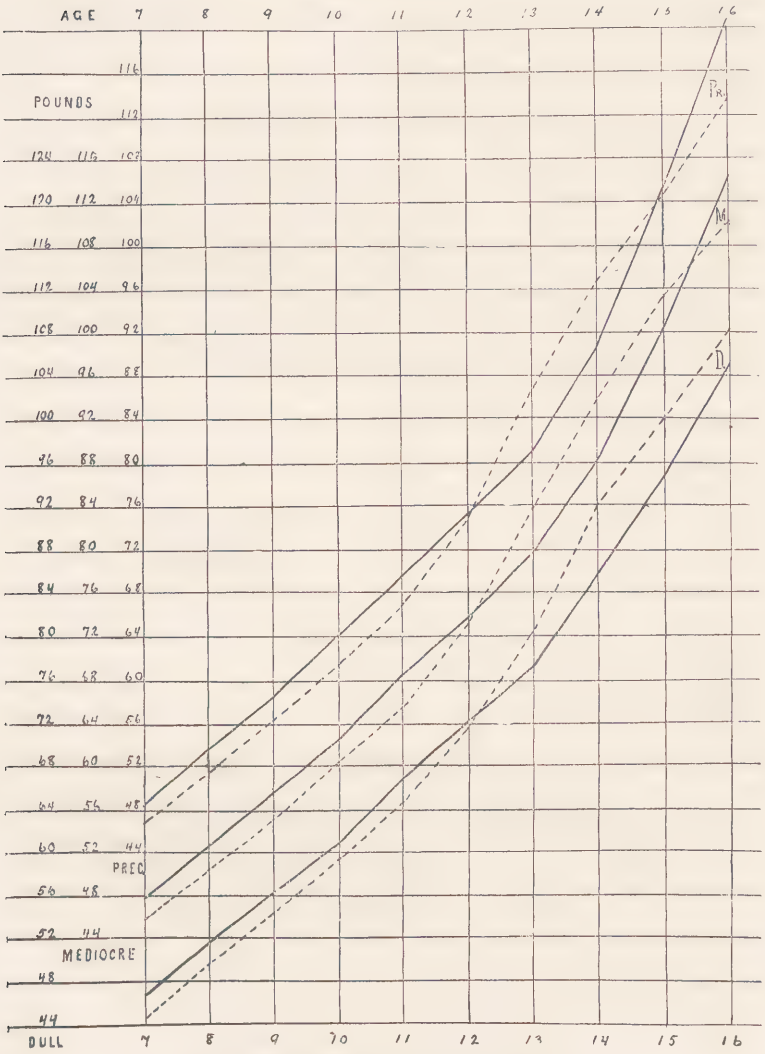
* The extent of this difference in number of observations is seen by comparing the columns on the left of Tables No. 2 and No. 3.

PLATE II.

THE RATE OF GROWTH IN WEIGHT OF DULL, MEDIOCRE AND PRECOCIOUS BOYS AND GIRLS.



FULL LINES REPRESENT BOYS' WEIGHT.
DASHED LINES REPRESENT GIRLS' WEIGHT.

This difference persists for about three years, and then the curves once more cross and the youth is once more heavier than the maid. In Plate II, the curves of girls' weights cross the boys' curves at the same age in dull, mediocre andprecocious children. *The point in the period of accelerated development at which girls become heavier than boys is the same in the dull, the mediocre and the precocious.*

The conclusions reached in this investigation are based on means and averages. How far they are applicable to individuals cannot be determined from the present data. For this, another method must be used. The same children must be weighed from year to year. The variation of the individual from the normal mean or average will then be known. But even without this information, a deduction of great practical importance can be made from the laws established by the present research. *No child whose weight is below the average of its age should be permitted to enter a school grade beyond the average of its age, except after such a physical examination as shall make it probable that the child's strength shall be equal to the strain.*

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